Space Weather Technical Forecast

Issued on Tuesday, 05 December 2023 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of a G1/Minor-Geomagnetic Storm early Day 1 but risk reducing as solar winds ease into the next few days. Chance of isolated M-Class flares (R1-R2 Blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is currently Moderate with the largest flare of the past 24 hours a M1.5 flare at 05/0639 UTC from what looks to be the small recently numbered AR3513 rounding the northeast limb. There are currently 9 sunspot regions on the disc, 7 of which are numbered with AR3500 and AR3501 no longer visible having rotated beyond the western limb. The two main complex regions on the disc are AR3510 and AR3511, close to center disc in the south. Both regions have seen continued slow intermediate growth but with some consolidation around the main spots though AR3511 has now lost its magnetic delta spot. The remaining regions on the visible disc appear small and stable or in slow decay.

Despite a number of CME signatures evidenced in coronagraph imagery during the past 24 hours, none are considered Earth-directed. However, a filament eruption from near AR3511 around 04/07000 UTC produced a CME that may give a glancing blow on Day 3 (07 Dec).

Solar Wind / Geomagnetic Activity: Solar wind parameters have been indicative of the steady arrival of a high-speed stream from coronal hole, CH76/-. Solar wind speeds, as observed by DSCOVR at L1, have been at elevated levels throughout, varying between 520-560 km/s. Density was between average and above average levels throughout. The Interplanetary Magnetic Field (IMF), Bt, was initially weak before rising to moderate levels. Since around 04/1540 UTC IMF increased more steeply and peaked at 15nT at around 05/0200 UTC before reducing back down to weak to moderate levels by the end of the period. The north-south component of the IMF (Bz), was largely positive initially, more variable through the second half of the period but only weakly fluctuating. Phi angle has been predominantly negative (towards the Sun). Resultant Geomagnetic activity was Quiet to Active (Kp 1-4).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels. GOES16 high energy (greater than 2MeV) electron flux has been Background. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu) with a steady trend. The observation at 05/0000 UTC was 1.49e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate with a chance for isolated M-flares (R1-R2 Blackouts) throughout.

Solar Wind / Geomagnetic Activity: A filament eruption that left the Sun around 04/0700 UTC is expected to miss Earth, but there is a very slight chance of a glancing blow on Day 3 (07 Dec). No further CMEs are currently thought to be Earth-directed.

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Enhancement of solar winds from the HSS from CH76/- is expected to persist through Days 1-2 (05-06 Dec) with winds at Elevated levels, possibly peaking around 600-620km/s Day 1. Winds are expected to slowly return to Slightly Elevated levels on Days 3-4 (07-08 Dec) in the absence of any further CME enhancement.

Geomagnetic activity is expected to be largely Quiet to Unsettled through the forecast period (Kp 1-3). There is a chance during Day 1 (05 Dec) that influences from the HSS may see activity increase to Active (Kp 4) and a slight chance of G1/Minor Geomagnetic Storm (Kp 5) levels. This risk reducing into the period as HSS influence reduces. There is a slight chance on Day 3 (07 Dec) that a glancing blow from a CME produce an Active or G1/Minor Geomagnetic Storm interval, but this is considered a low probability, with Enlil modelling a miss below Earth's orbit.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is forecast to remain at background levels with no Solar Radiation Storms expected.

Electron flux is at background levels. An increase towards Moderate to High diurnal levels is possible by late Day 2 or Day 3 (06-07 Dec) as the electron belts relax as the influence of the HSS wanes. The associated 24 hour electron fluence is expected to remain below the Active threshold, but gradually increasing from Day 2 onwards with a chance of exceeding the Active threshold into Day 3 or more likely Day 4 (07-08 Dec).

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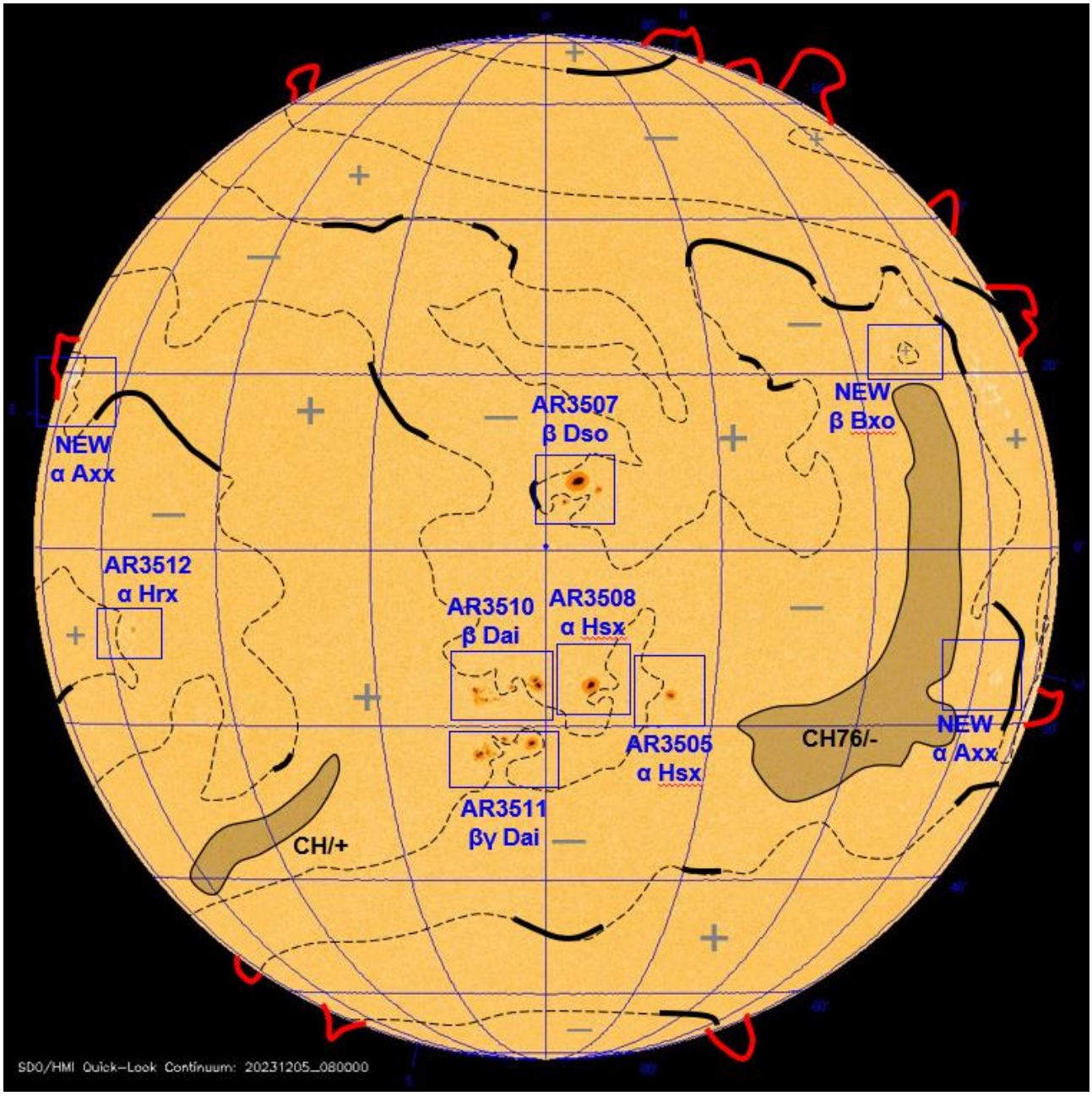
Figure 1. Solar Analysis Valid 05/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The CME produced by a filament eruption around 04/0700 UTC is expected to miss Earth, however, there is a very slight chance of some enhancement and a glancing blow on Day 3 (07 Dec). No further CMEs are currently thought to be Earth-directed.

Solar winds are currently at Elevated levels (560 km/s) due to the enhancement from a HSS from CH76/-. Enlil is currently providing good guidance on wind speeds. This coronal hole is a persistent feature and similar in size and position to the previous rotation. However, during the previous solar rotation a CME arrival masked the initial influence of the coronal hole. Strong winds of around 600-620km/s may occur at the peak during Day 1. Elevated speeds are likely to persist throughout Days 1-2 (05-06 Dec) before easing to Slightly Elevated levels on Days 3-4 (07-08 Dec). Should the glancing CME arrive on Day 3, some minor enhancement to wind speeds may be observed.

Geomagnetic activity is expected to be largely Quiet to Unsettled through the forecast period (Kp 1-3). There is a chance during Day 1 (05 Dec) that influences from the HSS may see activity increase to Active (Kp 4) and a slight chance of G1/Minor Geomagnetic Storm (Kp 5) levels. This risk reducing into the period as HSS influence reduces. There is a slight chance on Day 3 (07 Dec) that a glancing blow from a CME produce an Active or G1/Minor Geomagnetic Storm interval, but this is considered a low probability, with Enlil modelling a miss below Earth's orbit.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1222	Partial	Filament near AR3311	SE	630 km/s	07/1200 UTC	Slight chance of limited glancing impacts

Figure 2: Latest MOSWOC ENLIL output

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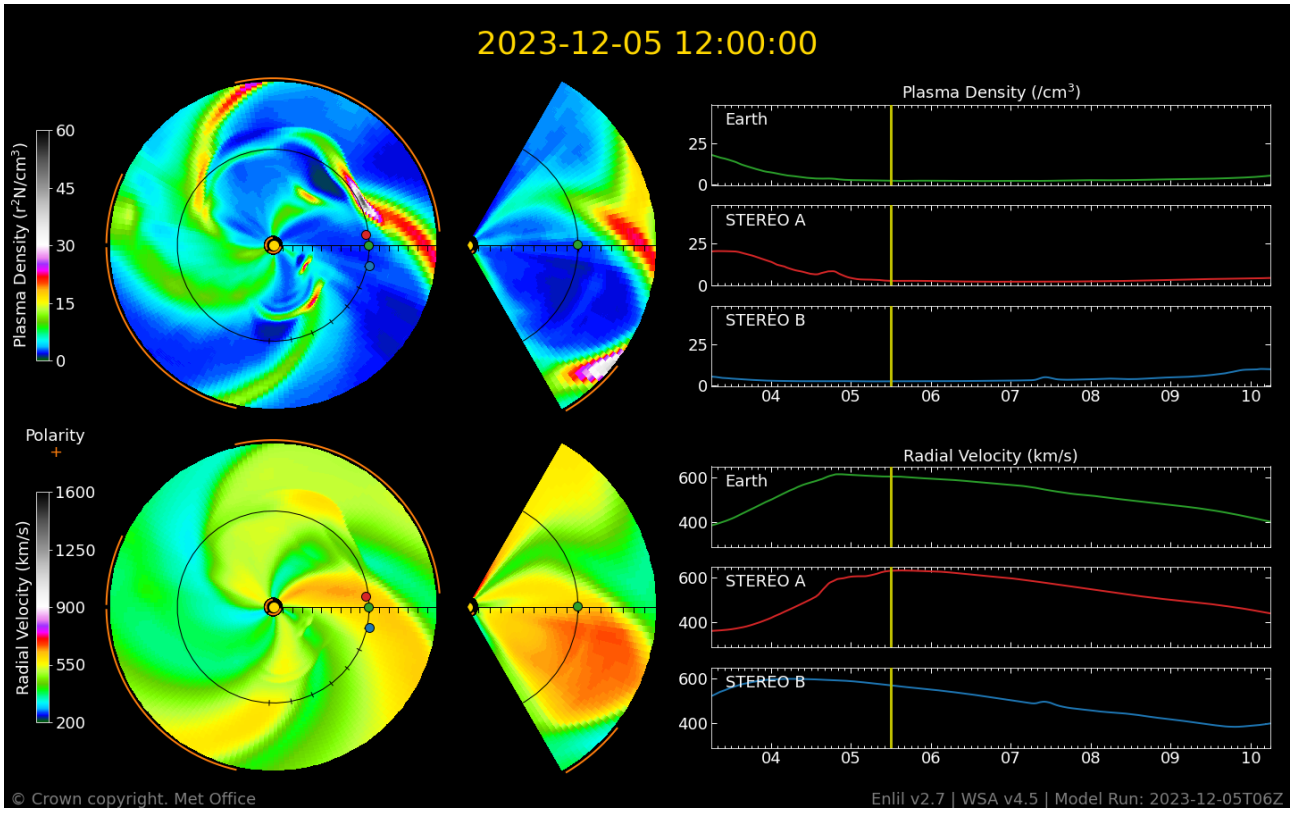

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Radio Blackouts - X-Ray Flares:
Solar activity is expected to be Low with a Chance of isolated M-flares (R1-R2 Blackouts), the risk reducing slightly into the period as the previously active AR3500 continues to depart the visible disc during Day 1, with the main risk of further significant flares now coming from the closely situated AR3510 and AR3511 near south center disk. Recent flare activity near the northeast limb suggest that one or more region currently emerging may also contribute to the flare risk, with this risk to be assessed in the coming days. Otherwise, no further significant returning regions are expected to rotate over the eastern horizon in the coming days from far side sounding imagery.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	35	35	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background and is expected to remain at this level. There is a very slight chance of S1/Minor Storm conditions being reached should any significant flares occur, mainly from AR3500 on the western limb initially but increasingly from the region near center disk as they rotate into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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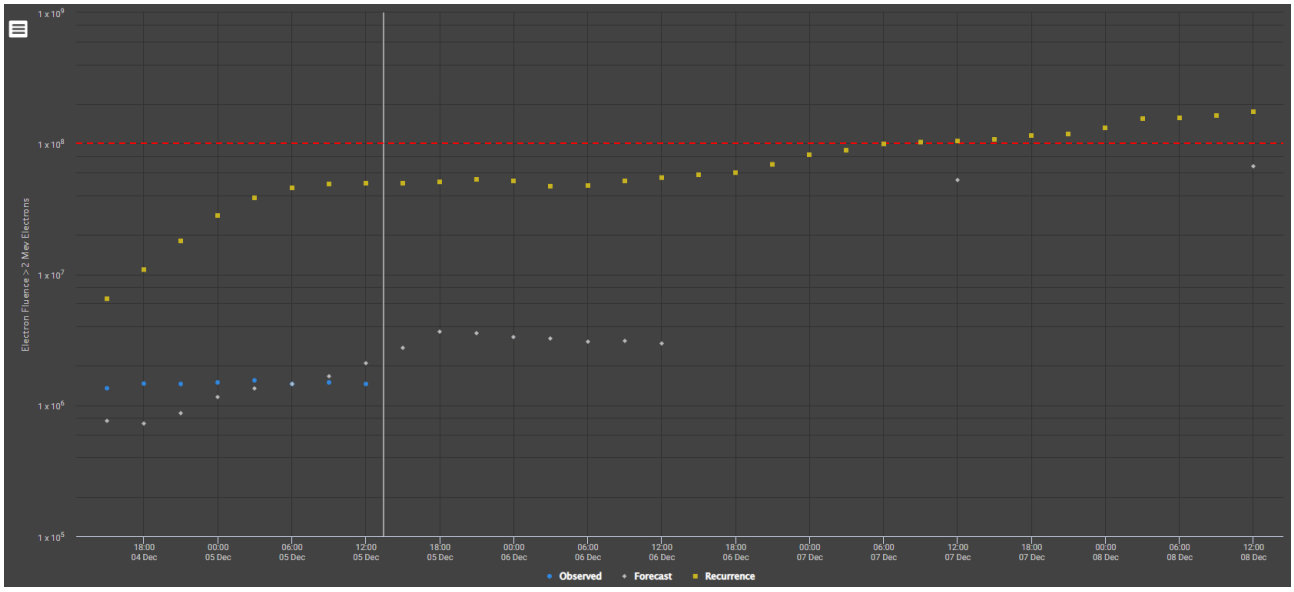
High Energy Electrons Event (≥ 2MeV):

Electron flux is at background levels with the Van Allen belts still suppressed following recent enhanced geomagnetic activity. Continued suppression is expected as a result of geomagnetic activity associated with the HSS from CH76/-. An increase towards Moderate to High diurnal levels is possible by later Day 2 or Day 3 (06-07 Dec) as the electron belts relax back towards ambient positions. However, the slight chance of a glancing blow from a CME on Day 3 reduces confidence in the forecast.

The associated 24 hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold. However, a rising trend is likely from Day 2 onwards with an increasing chance of exceeding the Active threshold into Day 3 or more likely Day 4 (07-08 Dec). Current REFM forecast is considered to be providing reasonable guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output



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